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Atchison, Topeka & Santa Fe
Railroad Company,

INSTRUCTIONS TO CIVIL ENGINEERS
CONCERNING
SURVEYS AND CONSTRUCTION.



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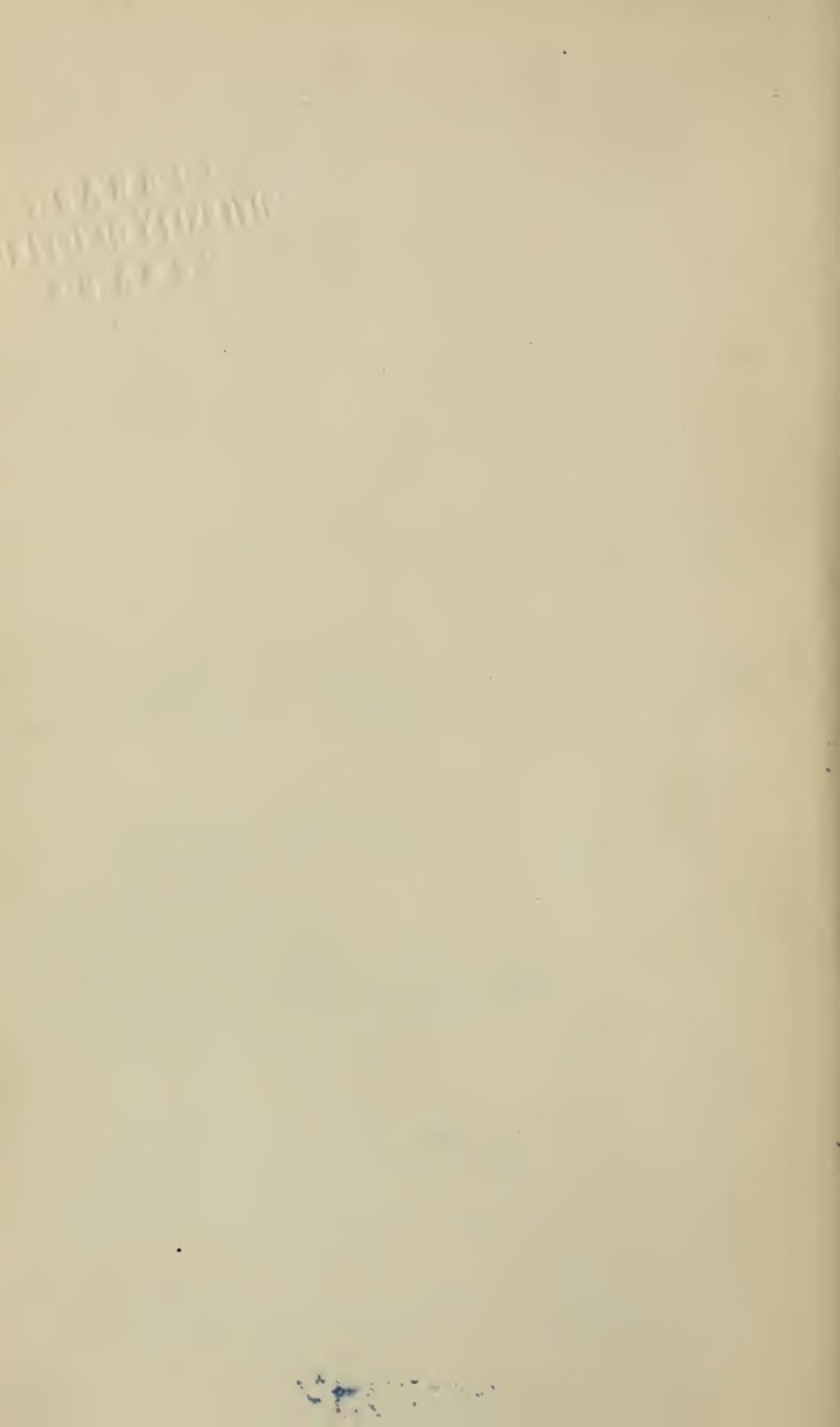


Atchison, Topeka & Santa Fe
Railroad Company.

INSTRUCTIONS TO
CIVIL ENGINEERS
CONCERNING
Surveys  Construction.

1883.

GEO. W. CRANE & CO., PRINTERS AND BINDERS,
TOPEKA, KANSAS.



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CHAPTER I.

SURVEYS.

1. Locating engineers have immediate charge of surveying parties and are expected to see that their parties are well supplied with instruments, tents, stationery, provisions, and all the tools and outfit needed for the proper and vigorous prosecution of their work. They are responsible for the honesty, sobriety, industry and competence of the men under their charge, and they must give personal attention to see that their Transit men, Level men and others fully understand their work and are conscientious in its performance. They must give special attention to see that the instruments are kept in adjustment; that all possible checks upon the accuracy of the work are used and that note books are neatly and accurately kept. They must see that their camps are neat and orderly, and that the cook uses provisions economically and cooks and serves the food neatly and cleanly.

2. Preliminary surveys must be run with care and must be made to approximate closely to the line which would be adopted on final location. All notes of preliminary surveys must be kept with as great care as if for final location.

3. Before the final location survey of any route is commenced the Locating Engineer will receive instructions from the Chief Engineer as to the maximum gradient and minimum radius of curves to be used on the

survey, the basis for comparing and equating the desirability and operating value of different lines between two common points, and such other instructions as may be needed for his guidance.

4. The maximum gradient will in all cases be understood as belonging only to straight lines, and the rate of ascent upon all curves must be sufficiently less than the maximum to compensate for the resistance to traction due to the curvature.

The following will govern:

When rate of maximum grade on straight line is	The compensation for curva- ture will be
0.6 or less per 100 feet.	0.06 feet per degree.
0.6 to 1.6 " " "	0.05 " " "
1.6 to 3.0 " " "	0.04 " " "

5. The maximum rate of curvature will not exceed 10 degrees per 100 feet, unless by special instructions from the Chief Engineer for each particular case.

A rate of curvature less than 1 degree per 100 feet should not be used except in cases where the intersection angle is less than 3 degrees.

Curves less than 300 feet in length are objectionable; the rate of curvature should be used so as to give at least the length named.

Reversed curves upon main lines are exceedingly objectionable and must not be used. Two curves in opposite directions must be joined by a tangent not less than 200 feet in length.

6. Locating engineers should give special attention to the determination of the necessary length of bridges and size of culverts, and should keep a note book in which are entered an estimate of the extent and a general description of the character of the area drained by each

water way; cross sections of streams at flood height, and any other items of importance bearing upon the question of drainage. These notes should be full and explicit, and should give the local names of creeks and small streams as well as the names of rivers, and should refer to the number of the nearest survey stake in describing all water ways.

7. The note books used will be Transit Book, Level Book, Memorandum Book, and Topography Book. Following are shown specimens of the ruling of Transit Book and Level Book, with the headings which are to be used in all cases:

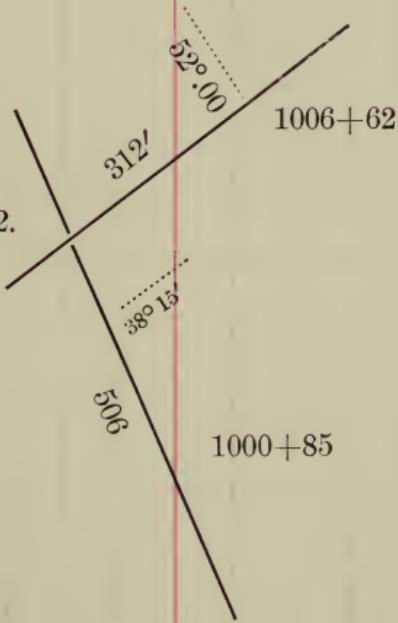
TRANSIT

STATION.	POINTS.	Description of Curve.	Elements of Curves.	Magnetic Course.
1008				
7				
6				N. 38° 20' W.
5	⊖ +60 P. T.		A. 9° 12'	
4	⊖ +30.5 P. I.		R. 2865	
3			T. 230.5	
2			L. 460	
1	⊖ P.C.	2° Left.		
1000				N. 29.08 W.

BOOK.

TOPOGRAPHY AND REMARKS.

N. W. Cor. Sec. 32.



LEVEL

STATION.	+	Height of Inst.	-	Elevation.	Benches and T. Ps.
	Sight.		Sight.		
Bench,	9.85	410.43			400.58
1001			7.5	402.9	
2			5.4	5.0	
3			3.9	6.5	
4			2.9	7.5	
5			2.6	7.8	
+ 60			1.0	9.4	
6			1.7	408.7	
Peg,	8.57	417.62	1.38		409.05
1007			7.6	410.0	

BOOK.

Bench 100 ft. Right of Station 1000 on Black Walnut tree.

Peg on stake 1 foot from Sta. 1006.

Memorandum Books are of the same size as Transit and Level Books, but have only blue rulings forming small squares. These books are to be used for keeping notes of water ways and for entering general items of information in regard to the line.

Topography books are larger and are ruled in squares to assist the Topographer in his work.

8. In commencing a survey, if the beginning of the line is at a junction with any constructed line of railroad, full notes of the connection must be taken and such measurements from depots, switches, or other important landmarks as will give full and complete information to enable a draughtsman to connect the notes of the proposed line with the notes and maps of the constructed line. In passing through towns or cities full notes of street connections must be taken to enable a draughtsman to locate the course of survey upon the town or city plat.

In commencing the level notes of a survey which starts from a connection with any constructed line of railroad, the Locating Engineer should, if possible, start from a Bench Mark of the constructed line and refer all notes of the survey to the datum of the bench from which he starts. If no such Bench can be found, or if the survey does not start from a connection with any constructed road, a Bench Mark should be made with an assumed elevation equal to its height above sea level as nearly as that height can be determined.

This Bench should, if possible, be situated upon the foundation of some permanent building or structure, and its location should be fully described. In the course of the survey Bench marks should be established at the end of each 2,000 feet of the survey, and should be upon the foundation of permanent buildings,

upon large trees, or upon stout stakes driven not less than one foot in the ground and standing not more than three inches above the surface. The elevation of Benches must be plainly marked with red chalk either upon the side of buildings, upon a "blazed" spot upon trees, or upon a stout guard stake driven a foot from the Bench Mark.

All Bench Marks must be fully described in the level notes as they are established, and at the back of each level book a few blank pages should be left, on which should be entered a list of the Benches upon that part of the line covered by the book, and a table of the alignment of the survey within the same limits.

9. The Topography must be carefully taken by actual measurements to important points and must correctly show contour lines where the surface of the ground would be intersected by horizontal planes at every 10 feet of height. These contours need be shown only at places where the surface is considerably broken or rolling. The Topographer must make careful measurements of all township or subdivision lines of the United States land surveys in the vicinity of the intersection of the same by the line of the railroad survey. These measurements should include the angle made by the railroad line with each township or section line, the station of the railroad survey at which the line intersects any land line, and the distance along the land line to the nearest section corner or quarter corner, and there should be a correct plat drawn in the Topography book, showing plainly all the above information, as shown on the right hand page of Transit book ruling above.

10. In order to secure accuracy of alignment upon straight lines the transit man should always take double

sights in establishing turning points, reversing the position of the axis of the telescope so as to correct any possible error of adjustment of the line of collimation.

Except on precipitous and impracticable ground the P. C. and P. T. of every curve must be set from the point of intersection of the tangents which are to be joined by the curve, and the tangent succeeding the curve should be run as a prolongation of the line from the intersection point to the P. T., rather than by turning an angle from a back sight on the curve.

In order as far as possible to prevent inaccuracy in the work of the level man care must be taken that the rod is held in a vertical position at all times, and especially upon turning points and bench marks, and to guard against errors in keeping the notes the rodman must carry a level book, in which he records all + sights and — sights upon turning points and bench marks, and makes the full calculation for each height of instrument and elevation of turning point or bench, checking the same with the calculations of the level man.

11. All profiles of surveyed lines must be made on profile paper, having a horizontal scale of 400 feet to one inch, and a vertical scale of 20 feet to one inch (known as "plate A").

Profiles must show the surface line, the proposed grade line, the height above the datum of all points where the rate of ascent or descent changes, the rate per 100 feet and per mile of all gradients, the beginning, end and rate of all curves, the proposed length of all bridges and dimensions of culverts, and notations of all proposed special work, such as changing channels of water courses, protection of embankments against action of water, etc., etc.

Profiles must begin at the left hand end of the sheet or roll of paper and run to the right, and the sheets or rolls must be of a uniform width of 10 inches.

No profile will be considered complete until plainly marked near the left hand upper corner with a title showing the character of the survey, whether preliminary or final; the corporate name of the railroad company for which the survey is made, the opening and closing station numbers, the proposed beginning and ending points of the survey, and the name of the locating engineer, who must see that this title is marked in ink upon all profiles sent from his office or camp. A sample piece of profile will be furnished on application.

12. Locating Engineers must make a weekly report to the Chief or Principal Assistant Engineer on every Saturday night, of the progress of his work during the week last past, with such information in regard to the general character of the country and other items as may be of interest, accompanying the report in the case of final location surveys, with maps and profiles of the portion of the line located since previous report, and of trial lines which are considered of sufficient value to justify consideration.

13. Upon the completion of any line of survey the locating engineer must send in to the Chief or Principal Assistant Engineer the original transit, level, topography and memorandum books of the survey. These books must be neat and plain, and if they contain any notes of abandoned surveys these notes must be indicated by two red ink lines drawn diagonally across the page and intersecting. The books must not be marked upon the outside of the covers, but upon the first ruled page of the book the title must be written in ink in the following form:

..... *Book No.*

..... *of a*

..... *Survey*

..... *for the*

..... *Railroad,*

from *to*

Station *to Station*

(*Transitman, Levelman or Topographer.*)

Locating Engineer.

CHAPTER II.

GRADING AND BRIDGE MASONRY.

14. Resident Engineers of construction will have charge of all labor performed in the construction of the road-bed, including bridge and culvert masonry, of all new lines, extensions and branches, and of the instruction and direction of all Division Engineers employed on such work.

They will be held responsible for the competence, sobriety and industry of all Division Engineers and are expected to use all possible checks to prevent errors in the measurement, calculation or classification of work done under their charge.

They must see that Division Engineers are supplied with instruments, stationery, tools and provisions, and that their camps are kept neat and food served neatly and cleanly.

15. Before the work of construction is commenced upon any route the Resident Engineer in charge must carefully examine the line to see if any improvement can be made in the location, and should submit to the Chief or Principal Assistant Engineer maps and profiles of any changes which he may think desirable; but no changes should be made without approval.

16. Division Engineers should be upon their divisions and have the line cross-sectioned, if possible, before the arrival of the contractors or other forces to begin the work of construction.

Resident Engineers must give personal attention to the instruction of Division Engineers in regard to cross section measurements and notes, and must from time to time take notice to see that the work is properly done and notes carefully kept. They must see that each Division Engineer has a correct profile of his division, showing grade lines, curves, bridge and culvert notes, and notes of all special work, such as changes of water course channels, rip-rap of banks, location of road crossings, etc., etc., and the Division Engineer must see that all such notes are scrupulously observed and the work done accordingly.

The following is the form of cross-section or construction books, with the headings which are to be used for the different columns:

CROSS SECTION

Station.	Surface.	Grade.	CROSS SECTIONS.
----------	----------	--------	-----------------

BOOK.

EXCAVATION.		Earth.	Embank- ment.	General Notes.
L. Rock.	S. Rock.			

17. When the rate of ascent or descent changes the gradient lines must be connected by vertical curves calculated by the following rules: From the vertex or intersection of the two gradient lines the distance to the corresponding point on the vertical curve is one-half the amount of divergence of the gradient lines at 100 feet from the intersection—in other words, one half the algebraic difference of the two rates per 100 feet of ascent or descent, ascent being positive and descent negative.

At 100 feet on either side of the vertex the distance from the gradient line to the curve should be $\frac{1}{8}$ the amount of divergence or algebraic difference as above, and at 200 feet on either side the gradient lines and the vertical curve are tangent.

The above rule should not be used when the amount of divergence of the gradient lines is more than two feet in 100 feet, but in such cases an intermediate gradient line should be introduced, not less than 400 feet in length, so as to allow of the application of the rule.

18. The surface of the road-bed upon all curves must be inclined toward the center of the curve at the rate of *one per cent.* for each degree in the index of the curve.

The centre line of the road-bed should be at the true grade, as shown by the profile, the inner side of the road-bed being below and the outer side above the profile grade. This difference in the height of the two sides of the road-bed must be considered in cross sectioning the line, but the quantities of material in excavations or embankments will be calculated from the cross section notes as if the surface of the road-bed was level. This inclination of the surface should be carried in full amount through the full length of the curve and should be

gradually brought to the level at distances outside the ends of the curve equal to 10 feet for each degree in the index of the curve.

19. Upon the completion of work upon any division the Resident Engineer must, as soon as practicable, complete and send to the Chief or Principal Assistant Engineer, a corrected profile of the division, showing all information required (see section 11) on profiles correctly, in accordance with the actual construction. He must also send in neat copies of the construction books of Division Engineers, in which all notes and quantities are entered in ink. Following the cross section notes of each mile, or section, of the line, there must appear the notes of all masonry, rip-rap, road crossings and all other work which has been done upon the section; following these notes there must be a general summation of the quantities of different classes of work which appear in the notes, and following this a statement of the "final estimate" for the section.

No marks are to be put on the outside of the covers of construction books which are to be sent in, either by Division Engineers or Resident Engineers, but the Resident Engineer must see that each book has its title written in ink upon the first ruled page of the book in the following form:

Construction Book

of Sections to of the Railroad,

from Station to Station

..... *Division Engineer.*

..... *Resident Engineer.*

20. Resident Engineers must give as much personal attention as possible to the details of the work of construction, so as to be fully posted upon all points, such

as the classification of material, etc. They must see that all work is done in accordance with specifications or instructions, and must be diligent to save expense in all ways that are consistent with good principles of engineering.

They must make weekly written reports to the Chief Engineer or his assistant of the progress of the work, calling attention to any want of proper energy on the part of contractors, or any disposition to neglect or slight their work.

21. Division Engineers have charge of laying out all work to be done on their divisions and of the instruction and direction of all contractors or foremen who undertake any work of grading or masonry.

22. Cross section measurements must be taken with great care so as to furnish an accurate basis for the calculation of quantities, and all notes of such measurements must be entered and kept in the construction book, according to the form shown above.

In cross section notes the sign + indicates excavation and the sign — indicates embankment. Grade points, or those where there are neither excavation nor embankment are indicated by the figures 0. 0. All notes of the depth of cutting or filling, except at the center line, must have the distance from the center line at which the observation is taken marked above the figures which show the depth.

In the absence of special instructions the following bases and slopes of cuttings and embankments will be used:

For embankment: Base, 14 feet; slope, $1\frac{1}{2}$ to 1.

For excavations in earth: Base, 20 feet; slope, $\frac{1}{2}$ to 1, for hard clay or prairie soil.

For excavations in wet adhesive clay: Base, 20 feet; slope, 1 to 1.

For excavations in sand, joint clay or springy ground: Base, 20 feet; slope, $1\frac{1}{2}$ to 1.

For excavations in loose rock: Base, 18 feet; slope, $\frac{1}{4}$ to 1.

For excavations in solid rock: Base, 16 feet; slope, $\frac{1}{2}$ to 1.

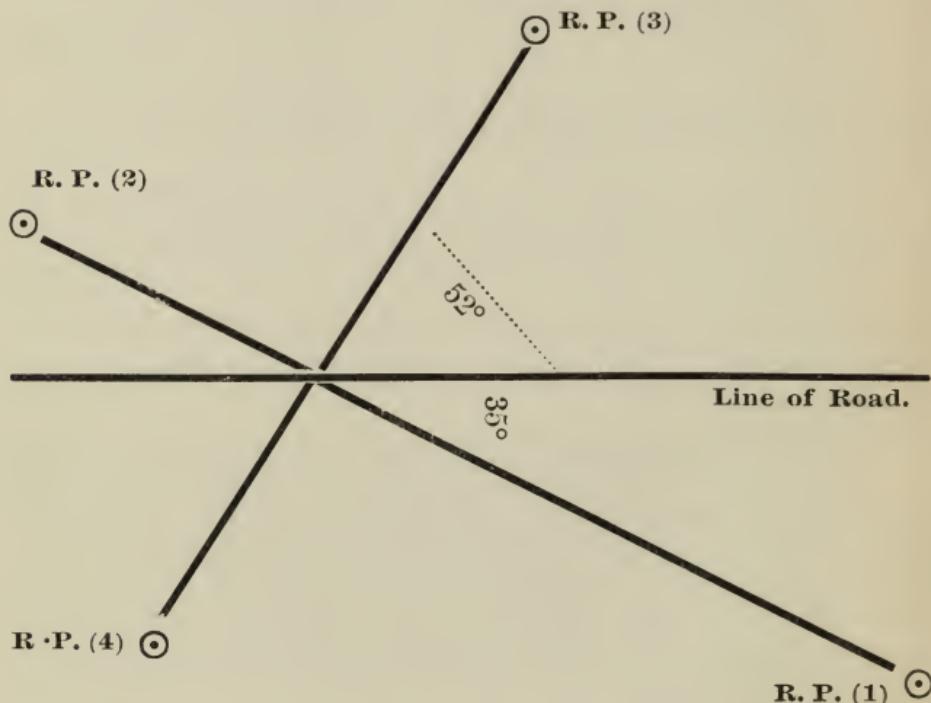
The width of the road-bed in all excavations will be 12 feet, and the width of the ditches such as to consume the full width of the base of the excavation outside of the road-bed. The depth of ditches in cutting is uniformly 1 foot.

If, as any excavation progresses, the character of the material changes so as to require a different base or slope, the Division Engineer must re-cross-section the work without delay and take such measurements as will enable him to calculate accurately the amount of material already taken out.

In passing from excavation to embankment, or the reverse, there must always be three cross sections taken, showing "grade points" on each side and at the center. "Grade points" at the sides should always be at a distance from the center equal to the half width of the embankment road-bed.

23. Division Engineers, while making cross section measurements, must carefully anchor the beginning and ending points of all curves and points of compound curves; also all turning points used by the transit man on straight lines, by setting substantial reference points in locations where they will not be disturbed during the work of construction. Reference points are preferred which do not depend upon measurement for determining

the position of the point witnessed, but find the point by the intersection of two lines, which should be as nearly as practicable at right angles with each other, thus:



The notes of these R. P.s should give their distance from the point witnessed, and the angles which the lines to reference points make with the line of the road, thus:

R. P. 35° Right, 200' and 138'

R. P. 52° Left, 100' and 132',

which shows that the line R. P. (1)—R. P. (2) makes an angle of 35° with the line of the road, and that the points (1) and (2) are respectively 200 feet and 138 feet from the point witnessed, and similarly of the points (3) and (4).

24. All extra work, such as ditches, dykes, road crossings, changes of channels, etc., must be cross sectioned as carefully as the main road-bed, and the notes as carefully kept.

Careful attention must be paid to the notes on the profile requiring special work, such as dykes, ditches, road crossings, etc., so as to arrange for the most economical performance of such work.

25. In case earth for making embankments is taken from borrow pits alongside, bermes of the following widths must be left between the slope stakes and the edge of borrow pits:

For banks under 6' in height, berme 6' wide.

For banks from 6' to 8' in height, berme 8' wide.

For banks over 8' in height, berme 10' wide, and the side of the borrow pit next to the berme must have a slope the same as that required for excavations in material of corresponding character. When earth from cuttings is wasted alongside, the edge of the waste bank must not be nearer than 10 feet from the edge of the cutting. The above instructions are important and must be strictly observed.

26. Before any portion of road bed is completed the Division Engineer must set center and grade stakes to guide contractors in finishing.

Grade stakes must be set on each side of the center stakes at a distance equal to the half width of road bed; they must be driven so that their tops shall be at the proper elevation for the surface of the road bed, and the tops should be chalked with red. On all curves the surface of the road bed must be inclined as directed in section 18.

27. During the progress of the work of construction upon any division the Division Engineer must go frequently along the line, to see that all work is being faithfully and honestly performed in accordance with the specifications. He must take such notes as will enable

him to make a correct classification of material taken from excavations in accordance with specifications, and must see that contractors do not make borrow pits or other excavations at places where it would cause injury, or danger of injury, to the road-bed.

28. As fast as they may find it consistent with careful watching of the progress of the work of construction, Division Engineers must calculate quantities of earth work from their cross-section notes. The calculation should be completed before the completion of the grading of the road bed.

29. Special attention must be paid to all masonry work, to see that it is done strictly in accordance with plans and specifications. Great care must be used in laying out the work, and contractors must not be allowed to commence the erection of any structure until the foundation has been examined and approved by the engineer in charge, and engineers are warned against taking any risks by building on unsatisfactory foundations. If you do not *know* the foundation is safe you must not allow the masons to begin work on piers, abutments or walls.

CHAPTER III.

TRACK, BRIDGES AND BUILDINGS.

30. Track Engineers are responsible for the proper construction of track superstructure and for the proper use, without waste, of all material for such construction. They must personally superintend the work, and must see that the material needed from day to day is ordered forward in good time, so as to avoid delays, and in case of delays from any cause they must so direct the employment of the forces engaged in the work as to cause no extra expense to the railroad company.

The following instructions in regard to laying track must be strictly followed:

31. Center stakes for the alignment of track and grade stakes for surfacing, must be set ahead of all other track work.

The center line must be marked by stout stakes, not less than 2 inches square, driven a foot or more into the ground, and standing from 4 to 8 inches above the surface. They must be set 200 feet apart on tangents and not more than 50 feet apart on curves, and must, as far as practicable, coincide with "stations" of the survey and profile. The Track Engineer should look out carefully to detect any deviations from true lines which may have been made in the location and construction of the road bed, and should correct such deviations if practicable.

Grade stakes should be set so that the tops of stakes will be at the proper heights for the upper surface of the cross-ties; they should be situated $2\frac{1}{2}$ feet on either side of the center of track, and should be set not more than 100 feet apart on straight lines, and not more than 50 feet apart on curves. The grade stakes must be properly set for all vertical curves and also for the super elevation of the outer rail of all alignment curves.

Vertical curves should be made to coincide with those which have been used by the Division Engineer in the surfacing of the road bed as nearly as possible, but stakes which are intermediate between the "stations" of the survey must be set so their tops shall be points in the vertical curve instead of in the chords drawn from station to station.

The super-elevation of the outer rail on curves shall be $\frac{1}{2}$ inch per degree in the index of the curve, but it must, in no case, exceed 5 inches. The super-elevation should be one-half above the profile grade and one-half below, so that the center line of track will remain at the true grade line.

The super-elevation should be carried in full amount through the full length of the curve and the track brought to a level at distances outside the ends of the curve equal to 10 feet for each degree in the index of the curve.

All grade stakes upon vertical curves and upon alignment curves of index greater than 3 degrees, should be set with the level working in a horizontal plane, but all stakes upon tangents or light curves may be set with the transit or level working in a plane parallel with that of the road bed.

32. Cross ties must be carefully bedded and surfaced with the use of straight edges and mauls, so that the top of the ties shall coincide with the top of grade stakes. Whenever the height of grade stakes is such as to require the filling of earth under the ties the filling must be of a width equal to the full length of the cross ties, and of a height such as to require two or more heavy blows of a 20-pound maul to bring each tie down to the proper surface.

When the road-bed requires cutting to bed the ties care should be taken to give them a solid bearing, and if the cutting is made so deep as to require to be filled in again with loose earth, then the same rule is applied as when filling is required.

Cross ties should be laid with the middle of the tie at the center of the track so that the ends will project equally outside the rails, and the ties must be spaced to equal distances apart, except the ties nearest the joints, which should be 18 inches apart on centers.

When the surface of the tie is "in wind" it must be adzed so as to give both rails a full bearing across the face of the tie.

33. Rails must be laid with even joints. In passing around curves rails of length 29 feet 9 inches will be furnished, which must be used to keep the joints even. Rails must not be cut unless in cases of necessity.

34. Track must be full spiked as it is laid, and spikes must be set vertical and driven home so closely as to hold the rail firmly to the tie, but not so hard as to break the head of the spike. Spikes *must* be driven in slots at joints.

35. Track must be gauged as spikes are driven at "joints," "centers" and "quarters," and no excuse is suf-

ficient to account for inaccurate gauging. Track on straight lines must be gauged to a width of 4 feet $8\frac{1}{2}$ inches, and on curves in accordance with the following table:

DEGREE.	GAUGE OF TRACK.	DEGREE.	GAUGE OF TRACK.
1	4 feet $8\frac{5}{8}$ inches.	11	4 feet 9 inches.
2	4 " $8\frac{5}{8}$ "	12	4 " $9\frac{1}{8}$ "
3	4 " $8\frac{3}{4}$ "	13	4 " $9\frac{1}{8}$ "
4	4 " $8\frac{3}{4}$ "	14	4 " $9\frac{1}{8}$ "
5	4 " $8\frac{3}{4}$ "	15	4 " $9\frac{1}{4}$ "
6	4 " $8\frac{7}{8}$ "	16	4 " $9\frac{1}{4}$ "
7	4 " $8\frac{7}{8}$ "	17	4 " $9\frac{1}{4}$ "
8	4 " $8\frac{7}{8}$ "	18	4 " $9\frac{3}{8}$ "
9	4 " 9 "	19	4 " $9\frac{3}{8}$ "
10	4 " 9 "	20	4 " $9\frac{1}{2}$ "

36. The splices at joints must be firmly secured in place by the full number of bolts, well drawn up, and special attention should be paid to the adjustment of any nut lock device which may be used.

37. Track must be carefully lined to the center stakes and must then be immediately filled in with earth. This filling shall be of a height of 4 inches above the top of the ties at the center of the track, and shall slope from thence to the bottom of the ties at their ends. Filling should consist of fine gravel or black soil. Large clods or clay should not be used.

38. As fast as track laying is fully completed all material which may have been left over by any reason, and all pieces of timber left from the construction of bridges, must be picked up and carried to the front or returned to the material yard. A lack of tidiness in the appearance of finished track will be considered evidence of an incompetent engineer.

39. Special attention should be given to the laying of switches, turnouts and frogs. There are only two sizes of frogs in use upon this road, viz: frogs of angles $6^{\circ} 22'$, and those of angle 9° —known respectively as number 9 and number $6\frac{1}{2}$ frogs.

All turnout curves are considered as beginning at the fixed end of the slide rail, and all engineers must make their calculations for determining the position of head-block and point of frog upon this basis. Sidings at different distances from the main track will be located, in the absence of special instructions, according to the following table, the turnouts being from straight lines:

TABLE SHOWING ALIGNMENT OF SIDINGS.

Distance of Siding from Main Track.	Turnout Curve.		Length of Tangent.	Curve returning parallel with Main track.	
	Degree.	Length.		Degree.	Length.
12 ft.	$7^{\circ} 30'$	95.8 ft.	.....	$7^{\circ} 30'$	95.8 ft.
13 "	$7^{\circ} 30'$	99.7 "	.....	$7^{\circ} 30'$	99.7 "
14 "	$7^{\circ} 30'$	103.4 "	.....	$7^{\circ} 30'$	103.4 "
15 "	$7^{\circ} 30'$	107.1 "	.....	$7^{\circ} 30'$	107.1 "
16 "	$7^{\circ} 30'$	110.7 "	.....	$7^{\circ} 30'$	110.7 "
17 "	$7^{\circ} 30'$	114.1 "	.....	$7^{\circ} 30'$	114.1 "
18 "	$7^{\circ} 30'$	117.4 "	.....	$7^{\circ} 30'$	117.4 "
19 "	$7^{\circ} 30'$	120.0 "	1.13 ft.	$7^{\circ} 30'$	120.0 "
20 "	$7^{\circ} 30'$	120.0 "	7.52 "	$7^{\circ} 30'$	120.0 "
22 "	$7^{\circ} 30'$	120.0 "	20.31 "	$7^{\circ} 30'$	120.0 "
24 "	$7^{\circ} 30'$	120.0 "	33.09 "	$7^{\circ} 30'$	120.0 "
26 "	$7^{\circ} 30'$	120.0 "	45.88 "	$7^{\circ} 30'$	120.0 "
28 "	$7^{\circ} 30'$	120.0 "	58.66 "	$7^{\circ} 30'$	120.0 "
30 "	$7^{\circ} 30'$	120.0 "	71.45 "	$7^{\circ} 30'$	120.0 "
40 "	$7^{\circ} 30'$	120.0 "	135.38 "	$7^{\circ} 30'$	120.0 "
50 "	$7^{\circ} 30'$	120.0 "	199.30 "	$7^{\circ} 30'$	120.0 "
60 "	$7^{\circ} 30'$	120.0 "	263.23 "	$7^{\circ} 30'$	120.0 "

Turnouts must be laid with standard sets of switch ties, which must be placed as shown in the diagrams of turnouts, which will be furnished to all track engineers. The ends of switch ties must be cut off to a line parallel with the nearest rail. Guard rails opposite frogs shall be cut 12' long and bent to a standard pattern upon formers, which will be furnished. The gauge of track of all turnout leads shall be 4' 8 $\frac{7}{8}$ ", and this width must extend from the fixed end of the slide rails to the heel of the frog.

40. Bridge and Building Engineers will lay out and superintend the erection of all Pile and Trestle bridges, the false work and superstructure of all Truss bridges, and the foundation and superstructure of all buildings which are to be erected as a part of the original construction of any branch or extension, and will be held responsible to see that all structures are located and laid out in accordance with plans and instructions, and that all work is done in accordance with plans and specifications. They will be governed by the following instructions:

41. In the construction of pile and trestle bridges a competent inspector must be retained, whose duty it shall be to watch the driving of piles at all times, and to keep a record of all piles driven. The inspector shall require piles to be driven such depth as will make them secure against being washed out by the scour of streams as well as against sinking under the passage of trains and engines. He must examine the foundation for the subsills of all trestle bents to see that it is satisfactory. The record of all pile and trestle bridges shall be kept in a Memorandum Book, and for convenience in designating any particular stick of timber in a bridge he will call the first bent of

piles or trestle, and its succeeding span, "Panel A," the second bent and span "Panel B," etc. Piles, posts, stringers or guard rails will be numbered from left to right, and the bridge ties will be numbered in the same direction as the letters of the panels. The initial point of all branches and extensions will be the junction with the present constructed line.

In accordance with the above plan it is easy to understand the location of a timber designated as Pile B 3, Stringer A 5, or Bridge Tie 38, in any bridge.

The record kept by the inspector must show the depth to which each pile is driven, the depth driven by the last five blows of the hammer, and the depth driven by the last blow. The form of the record is shown below:

BRIDGE No. 1,000, AT STATION 4999.					BRIDGE No. 1000, AT STATION 4999.				
PANEL A.					PANEL Z.				
Pile.	Deep.	Last 5 Blows.	Last Blow.	Fall of Hammer.	Pile.	Deep.	Last 5 Blows.	Last Blow.	Fall of Hammer.
Wing					Wing				
1	8 ft	2 ft,	3 inch.	28'	1	.....	.....	.....	.....
2	9 "	2½ "	5 "	28'	2				
1	14 "	1' 3"	½ "	29'	1				
2	14½ ft	2' 0"	1½ "	30'	2				
3	13 ft.	1' 6"	1 "	30'	3				
4	15 ft.	2' 0"	2 "	30'	4				
PANEL B									
1	.....	.....	.....	.....	The soil at this bridge is sandy. At a depth of about 13 feet below grade the piles strike a stratum of hard material, into which piles cannot be driven more than 2 or 3 feet.				
2									
3									
4									

This record book of the inspector will be turned over to the Bridge Engineer, who will then make up a complete record for each bridge in form, as shown below, in which a represents the height of piles from the sur-

face of the ground to the top of cap timber, and b represents the length of the pile below the surface of the ground.

Following the record of the piles there must be a complete bill of piles and other material used in the construction of the bridge, and a memorandum of any facts of interest or importance connected with the situation of the bridge or its surroundings.

BRIDGE No. 1000,					AT STATION 4999.
	1	2	3	4	
A.	a=6 $\frac{1}{2}$ b=14	a=7 b=14 $\frac{1}{2}$	a=8 $\frac{1}{2}$ b=13	a=9 b=15	This is a Pile bridge. The piles are driven in sand, striking a stratum of hard clay at a depth of 20 feet below the cap timbers.
B.	a=12 b=15 $\frac{1}{2}$				
Z.					

WING PILES.					
	1	2	3	4	
A.	a=4' b=8	a=6' b=9			
Z.					

BILL OF PILES USED.					
	1	2	3	4	
Piles 16' long.					
" 18' "					
" 24' "					
" 28' "					
" 30' "					

In this record, and in their proper place, all timber culverts and cattle guards must be entered with description, dimensions and bill of material; also all Truss Bridges, with location, description, dimensions and bill

of material in the floor system, not belonging to the bridge proper.

42. The location for all buildings will be decided in the office of the Chief Engineer, and the Bridge and Building Engineer will receive instructions in regard to location through the superintendent of construction or track engineer. Special care must be taken in the laying out and construction of foundations, and a full record must be kept of the dimensions of all masonry built.

The following rules will govern the location of all buildings and platforms as to their distance from tracks: The tops of all platforms adjacent to the main track should be 12 inches above the top of the rail (conforming to the grade of the track), and the nearest edge of the platform 2 feet 9 inches from the gauge side the rail.

The tops of all freight platforms on side tracks for general use should be 3 feet 8 inches above the top of rail on side track (conforming to grade of track), and the edge of platform 3 feet 3 inches from the gauge side of the nearest rail.

No building should be located nearer than 7 feet in the clear from the center of the main track.

No building should be nearer than 6 feet from the center of any side track, which is used for meeting and passing trains or for general purposes.

On side tracks to be used for special purposes, such as coaling engines from elevated coal chutes and similar uses, the demand must establish the distance, provided no building or structure is placed nearer than 5 feet 6 inches from the center of any track.

All buildings, corn cribs, or other structures, erected by corporations or private parties, and all stone, tie, or

timber piles for Company use, should not be located nearer than 6 feet from the nearest rail.

Telegraph signals at stations should, if practicable, be so located that the lever shaft inside the building will be at the right hand of the telegraph operator as he sits at his desk or table, and so near him that he can turn the signal without leaving his seat. The bottom of the signal vane should not be less than 7 feet 6 inches nor more than 10 feet above the platform. The center of the vane shaft should be 8 feet 6 inches from the center of the track.

43. The Bridge and Building Engineer will be expected to look out for the proper use of material furnished to see that it is not used wastefully. He must also see that each bill of material for each structure is delivered as ordered, and not mixed up so as to work to waste.

